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EXAMINER	
PHAM, THANH V	

ART UNIT	PAPER NUMBER
2823	

NOTIFICATION DATE	DELIVERY MODE
08/17/2007	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

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Office Action Summary	Application No.	Applicant(s)	
	10/500,494	PARK ET AL.	
	Examiner	Art Unit	
	Thanh V. Pham	2823	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *05 June 2007*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-3,5-7,9 and 21-24* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-3, 5-7, 9 and 21-24* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Response to Amendment

Claim Rejections - 35 USC § 103

1. The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

2. Claims 1 and 6-7 are rejected under 35 U.S.C. 103(a) as being unpatentable over Soininen et al. US 6,482,740 B2 in combination with Nakamo et al. US Pub 20010030366 A1 (US 6,680,540 B2).

Re claim 1, the Soininen et al. reference discloses (col. 2, line 35 to col. 3,line 5) a method for forming copper interconnect comprising:

providing an insulation layer 6/8/10/12 having a damascene trench including side walls (fig. 1);

forming a barrier layer 14/16 using Ru or Re or their alloys *on* a surface of an insulation/dielectric layer 6/8/10/12 on said substrate, a layer 16 of ruthenium or ruthenium alloys is considered as a secondary barrier layer formed on a primary barrier 14 of nitride and formed by using an atomic layer deposition method

> inert metals, such as platinum group metals, **or** conductive metal oxides, such as RuO_2, must be used adjacent to the high-k metal oxides (col. 4, lines 16-19).
>
> the manufacture of conductive thin films, preferably comprising one or more of the following elements: *rhenium*, *ruthenium*, osmium ... iridium, nickel ...platinum ...a metal oxide layer by an ALD type process and essentially converting the metal oxide into an elemental metal to provide sufficient conductive for the thin film. A surprising finding related to the present invention is that the film has very good adhesion to the substrate, even after a reduction step (col. 5, lines 5-25).
>
> ...a substrate with open trenches and vias is provided into an ALD reaction chamber. ... A metal oxide thin film is grown on the diffusion barrier 14 from

> alternate pulses of a metal source chemical and oxygen source chemical... The metal oxide film is reduced into a metal layer and used as a seed layer 16 for an electroplating process (col. 7, lines 21-36);

and forming a copper layer 18 on the surface of said ruthenium or ruthenium alloys adhesion layer using CVD

> alternatives for copper electroplating (step 9) are electroless plating, physical vapor deposition (PVD) and chemical vapor deposition (CVD). A seed layer (c.f Step 8) is only needed for the electroplating process. Traditionally such a seed layer is deposited by chemical vapor deposition (CVD) ... One can envision a seed layer that acts as a nucleation layer for the CVD process (col. 3, lines 15-35).

The Soininen et al. reference discloses forming the ruthenium or ruthenium alloys on another diffusion layer of nitride, it does not disclose forming the ruthenium or ruthenium alloys directly on the insulation layer.

The Nakano et al. reference discloses a method for forming copper interconnection conductors for interconnecting integrated circuits on a substrate (figs. 10, e.g.) comprising:

providing an insulation layer 4 having a damascene trench 7/10 therein on a substrate, the damascene trench including sidewalls (fig. 10c);

forming a barrier layer 3 using rhenium alloy film (abstract) directly on surfaces of the insulation layer 4 including the sidewalls within the damascene trench; and

forming a copper layer 6 directly on said barrier layer 3 such that the barrier layer intervenes between the copper layer and the sidewalls of the damascene trench within the insulation layer (fig. 10f).

The Nakano et al. reference recognizes the "hindering reduction of inter-wiring electric capacity" when using metal nitride or silicon nitride as a barrier layer ([0007]-

[0008]). It provides rhenium alloy film as a solution "to cover the top of the copper wiring formed in the insulation film and a barrier film surrounding the side and bottom of the copper wiring, wherein said wire protective film and/or barrier film is formed with ... alloy film containing ... rhenium ..." ([0017]).

The Nakano et al. reference discloses neither *using ALD* in forming the barrier layer of Ru or Re or their alloys nor *using CVD* in forming the Cu/metal layer.

It would have been obvious to one of ordinary skill in the art at the time of the invention to provide the barrier formation of Soininen et al. with the metal alloy as taught by Nakamo et al. because the barrier of metal alloy of Nakamo et al. would provide the barrier with "metallic material allowing electric capacity to be reduced" (Makano et al.'s [0012]) in forming copper interconnection conductors. Alternately, it would have been obvious to one of ordinary skill in the art at the time of the invention to provide the method of Makano et al. with ALD technique for depositing the barrier layer because ALD as taught in Soininen et al. would provide "sufficient conductivity for the thin film" and "very good adhesion to the substrate" (Soininen et al.'s col. 5, lines 10-17).

Re claim 6, the Soininen et al. reference discloses forming said copper layer further comprises using an electroplating method (step 9. Vias and trenches are filled with copper by an electroplating process, col. 3, lines 6-7).

Re claim 7, the Soininen et al. reference discloses forming said copper comprises sequentially using CVD followed by the electroplating method (the "alternatives" as extracted above).

3. Claims 2-3, 5, 9 and 21-24 are rejected under 35 U.S.C. 103(a) as being unpatentable over the combination of Makano et al./Soininen et al. as applied to claims 1 and 6-7 above, and further in view of Kim et al. US 6,936,535 B2, Koh et al. US 6,720,262 B2 and Gelatos et al. US 5,391,517.

The combination discloses substantially all of the instant invention but lacks the atomic ratio of ruthenium or rhenium in an alloy (re claims 2 and 9), PE-ALD (re claim 3), iodine or an iodine compound as a catalyst for copper CVD (re claim 5) and CVD using a carbon-containing or fluorine-containing copper precursor or using a copper precursor comprising (hexafluoroacetylacetonate hfac) (Cu copper) (vinyltrimethylsilane vtms) (re claims 21-24).

Re claim 3, the Kim et al. reference discloses "the reactive metal layer may also be deposited by any method known in the art, such as by PVD, CVD, ALD or plasma enhanced ALD (PE-ALD) processes" (col. 10, lines 24-26).

It would have been obvious to one of ordinary skill in the art at the time of the invention to apply known plasma enhanced ALD (PE-ALD) processes because plasma enhanced ALD (PE-ALD) processes would provide the atomic layer deposition of the combination of Kirlin et al./Soininen et al. with an equivalent "self-limitingly, no more than a monolayer" at a time as taught by Kim (col. 9, lines 64-65).

Re claim 5, the Koh et al. reference discloses "in a first aspect of the present invention, a method of using iodine or bromine as a catalyst in conjunction with a copper CVD method in filling trenches, via holes and contacts without creating undesirable pinch-offs and voids is disclosed and presented" (col. 2 lines 45-53).

It would have been obvious to one of ordinary skill in the art at the time of the invention to provide the method of the combination with iodine as a catalyst in conjunction with a copper CVD because iodine as a catalyst in conjunction with a copper CVD would provide the method without creating undesirable pinch-offs and voids as taught by Koh et al.

Re claims 2 and 9, choice of ratio of elements would have been a matter of routine optimization because ratio of elements is known to affect device properties and would depend on the desired device density on the finished wafer and the desired device characteristics. One of ordinary skill in the art would have been led to the recited ratio of elements, 50% or more Ru or Re in the alloys, through routine experimentation to achieve desired deposition and reaction rates.

Re claims 21-24, the Gelatos et al. reference discloses (hexafluoroacetylacetonate hfac) (Cu copper) (vinyltrimethylsilane vtms) is used in CVD process to deposit copper into trenches.

It would have been obvious to one of ordinary skill in the art at the time of the invention to provide (hexafluoroacetylacetonate hfac) (Cu copper) (vinyltrimethylsilane vtms) as a carbon-containing or fluorine-containing copper precursor or a copper precursor comprising (hexafluoroacetylacetonate hfac) (Cu copper) (vinyltrimethylsilane vtms) because (hfac)Cu(vtms) would be selected in accordance with the Cu CVD process as taught by Kirlin et al./Soininen et al. The use of (hfac)Cu(vtms) as copper precursor (carbon-containing or fluorine-containing) for CVD is well known to those skill in the art as taught by Gelatos et al.

Response to Arguments

4. Applicant's arguments with respect to amended claim 1 and its dependents have been considered but are moot in view of the new ground(s) of rejection.

Conclusion

5. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

6. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

7. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Thanh V. Pham whose telephone number is 571-272-1866. The examiner can normally be reached on M-T (6:30-5:00).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Matthew Smith can be reached on 571-272-1907. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/George Fourson/
George Fourson, AU 2923

TJP

08/07/2007